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Southern California Beach Processes Study

Torrey Pines Field Site

6th Quarterly Report
31 August 2002

to

California Resources Agency
and
California Department of Boating and Waterways

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BACKGROUND:
The objective of the Southern California Beach Processes Study is to develop an improved understanding of how sand is transported by nearshore waves and currents, thus improving the technical basis for the design of beach nourishment projects. The first project in this study, funded by the State of California, involves the simultaneous observations of nearshore waves and sand level changes at the SANDAG-sponsored beach nourishment project at Torrey Pines State Beach. These observations will be used to calibrate and evaluate existing computer models for the wave-driven evolution of a nourished beach, and eventually for the development and testing for new models. Torrey Pines Beach, located at the border between the cities of San Diego and Del Mar, was nourished during late April 2001 with nominally 191,000 cubic m of sand. The sand was deposited on the beach above the low tide level and over a 500 m alongshore span, forming an elevated pad of sand (Figure 1b for nourishment location). This study was described in a presentation at the California Shore and Beach Preservation/California Coastal Coalition 2001 Annual Conference Restoring the Beach, Science, Policy and Funding, held in San Diego on 8-10 November. A description of the Torrey Pines Beach Nourishment Project may be accessed through the http://cdip.ucsd.edu/SCBPS/homepage.shtml website. In addition to a Project Overview and Field Operations section, examples of survey ranges and bathymetry are displayed. Following publication, the Quarterly Reports are included on this site.

SAND LEVEL SURVEYS:
Since the last quarterly report, two additional surveys of sand levels have been acquired that span the same region as in the first 22 surveys. The first began on 2 July, 2002 and the second on 13 August, 2002. Cross-shore survey transects extend from the base of the Torrey Pines cliffs or Highway 101 onshore to about the 8 m depth contour offshore. The alongshore spacing between cross-shore survey lines is 20 m for a 700 m-long stretch of beach centered on the originally nourished site, and 100 m for additional 1 km-long stretches of beach up and down coast of the original nourishment.

Tracks for these two surveys are shown in the (a) panels of Figures 1-2, and indicate the second survey had generally good spatial coverage including overlap between the high tide jetski surveys and the low tide beach surveys. In the first survey overlap between the offshore (jetski) and onshore (ATV/dolly) surveys is lacking, owing to rough wave conditions. Bathymetry for the entire surveyed region, and for the closely (20 m) spaced alongshore lines near the nourishment site, are shown in the (b) panels of Figures 1-2. Changes in sand level near the nourishment site, relative to the first post-nourishment survey (27 April 01), and relative to the preceding survey are shown in the (c) panels of Figures 1-2. The right hand panels in Figures 1c and 2c show the continuing shoreward migration of sand (yellow) since the previous surveys.

Cross-shore profiles at alongshore locations representative of the fill area and the beaches to the north and south (transects 96, 106 and 88, figure 3a) show that between 29 April 02 and 2 July 02 the accretion occurred just seaward of mean sea level (Figure 3b). Between 7 July 02 and 13 August 02, the accumulation had moved above mean sea level and the position of mean sea level moved offshore approximately 20 m (Figure 3c). A major exception to this pattern occurred at the mouth of the Los Penasquitos Lagoon where the beach was eroded about 0.5m and there was a substantial accumulation in the ebb shoal (see cover photographs and discussion below.)

WAVE MEASUREMENTS AND MODELING:
Wave data was collected continuously during the last quarter at the Torrey Pines Outer Buoy site (550 m depth) and the Torrey Pines Inner Buoy site (20 m). Wave parameters from the two buoys are shown in Figures 4a-c. June-August are "beach building" southern swell months for the California wave climate. The distant Southern Ocean storms result in smaller, long period south swell arrivals at Torrey Pines that enhance the shoreward and northward transport of sediment. The (blue) outer buoy peak directions tracking near the 200 degree line in the lower panels of Figs 4a-c indicates a south swell was dominant in the Torrey Pines region. Compared to the same months in 2001, the 2002 southern swell season got off to a very slow start. June 2002 was dominated by south swell for approximately 30% of the time, and July 2002 approximately 50% of the time. In 2001, south swell dominated for 50% and 90% respectively during these two months. As a result, relatively late summer beach accretion and enhanced southern transport of sand by local NW wind seas might be expected during this quarter.

INFLUENCES OF LOS PENASQUITOS LAGOON:
The mouth of this lagoon, pictured on the cover of this report, is a few hundred meters north of the nourishment site and within the area surveyed. During periods of high tide ranges there is substantial flow in and out of the lagoon. Beach sediment is transported by these flows forming an ebb shoal on the nearshore and a flood shoal within the lagoon. The interaction of the ebb flow jet with the surf zone can result in significant and rapid changes in the shape of the shoreline which must be considered as anomalous when attempting to assess the impact of the waves alone. A further complication in accounting for changes in the amount of sediment in the system has arisen because, on two occasions during this project, sand has been removed from the flood shoal in the lagoon and deposited on the beach. The 17,000 m^3 volume of the first excavation (29 Jan – 9 Feb 02) is about 10% of the initial nourishment volume. The volume of the second case is unknown but was visually less than the first case. These operations, conducted by the Park Service, are intended to assist in keeping the lagoon mouth open to reduce the salinity variation within the lagoon. They will have an unknown effect on the ability of numerical models to recreate the response of this site to wave forcing.

BEACH RESPONSE MODELING:
SBEACH, the Corps of Engineers-developed software for storm-induced erosion of beaches or nourishment sites was exhaustively tested on the data set from the November 2001 storm which almost completely eroded the Torrey Pines beach. This software is used extensively by the Corps of Engineers to predict the performance of beach fill designs. It is commercially available in a MS Windows-compatible format through Veri-Tech Inc.

SBEACH contains a total of seven parameters with selectable values that may influence the model's performance. The program limits each of these to a min-max range. The test of the model capability began with providing a pre-storm profile averaged over three adjacent profile lines. Three such profiles were tested – one in the middle of the nourishment area and one each in the center of the un-nourished areas on either side. The driving force time history consisted of the wave significant height and peak period at half hour intervals as well as the tide levels at the same interval. Each of the seven assignable parameters was set to both its maximum and its minimum value in the allowable range while the others were held at their default value (typically mid-range.) The model was then executed and the total erosion was calculated and compared with the actual erosion determined from the measured post-storm profiles. This exercise provided guidance as to the effect of each of the parameters on the results of the model.

Assigning realistic values of known parameters such as water temperature, sand size and beach slope and default values of the other, rather obscure factors produced only a small fraction of the observed erosion. One by one, the parameters were changed to that limit value (max or min) which had produced the maximum erosion in the screening test described above. Even with all of the parameters set to the values expected to maximize erosion – which involved such unrealistic assumptions as water at 0 °C and sand size at half its true value – SBEACH was still incapable of predicting the erosion patterns actually experienced at the site. Figure 5 shows the pre-storm and post-storm measured profiles (averaged over three adjacent lines) near the center of the nourishment area as well as the maximized predicted contour by SBEACH. Although it is recognized that the high berm in the nourished area was anomalous, the model's performance was also unsatisfactory in predicting changes in the un-nourished beaches on either side (not shown).

It is clear that SBEACH, which was developed empirically from laboratory experiments and some East Coast field observations, does not adequately predict the behavior of this Southern California beach. No further effort with this software is anticipated. The companion software from the Corps of Engineers, GENESIS, which is designed to predict shoreline contour changes produced by gradients in longshore transport, will be tested next.

FEDERALLY FUNDED REGIONAL STUDY:

The Dana Point to Point La Jolla survey program funded by the Corps of Engineers was described in the 5th quarterly report (31 May, 2002.) Lidar and aerial video surveys of the region were completed in May. As originally conceived, the SHOALS airborne Lidar bathymetry system would also collect data concurrently, or nearly so. However, the SHOALS schedule did not accommodate that plan. The SHOALS team arrived in the area on June 26th and data collection began the next day. Operations were hampered, however, by persistent coastal fog (a typical condition on the southern California coast). By the 4th of July weekend, the survey target coverage was not quite 50% complete. SHOALS management began to contemplate shifting to another program to take advantage of clearer weather, and on July 15th did so. The team returned to our work area on August 6th. After correcting some equipment problems, the survey resumed. Operations continued until August 22nd, when the SHOALS program management terminated their effort. Good bathymetry was apparently acquired to a depth of 15 to 20 meters in the southern and central parts of the survey area (to Camp Pendleton, just south of San Onofre figure 7), In the northern region turbidity was a much greater problem. From San Onofre to Dana Point, penetration was limited to about 5 meters depth (figure 7c).

All of the survey contractors are still processing data. However raw results from the UT Lidar survey of 22 May, which contains all features without filtering, has been received. Figure 6 illustrates how the portion of this survey in the vicinity of the Torrey Pines site can be combined with the conventional survey data.

Video overflights were conducted 21-23 May, 2002 in conjunction with previously mentioned surveys. Flight tracks covered the region from the border to Dana Pt. (Figure 8a). Snapshots from the video representing Blacks Beach (Figure 8b) and Camp Pendleton (Figure 8c) are included in this report.

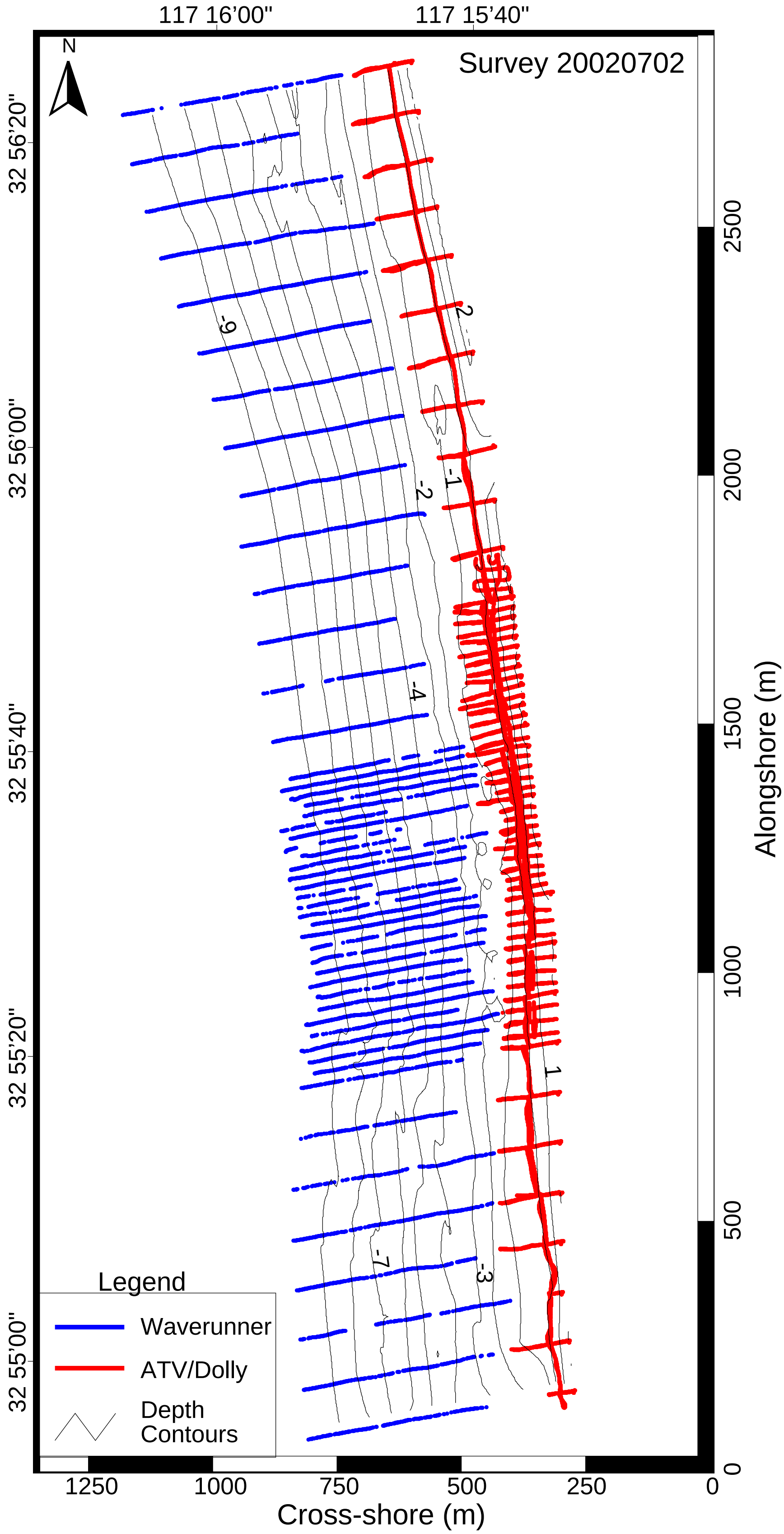

FIGURE 1a.
Survey starting 02 July 02. Blue lines are waverunner tracks (offshore). Red lines are ATV/dolly tracks (onshore). Black lines are depth contours in meters.

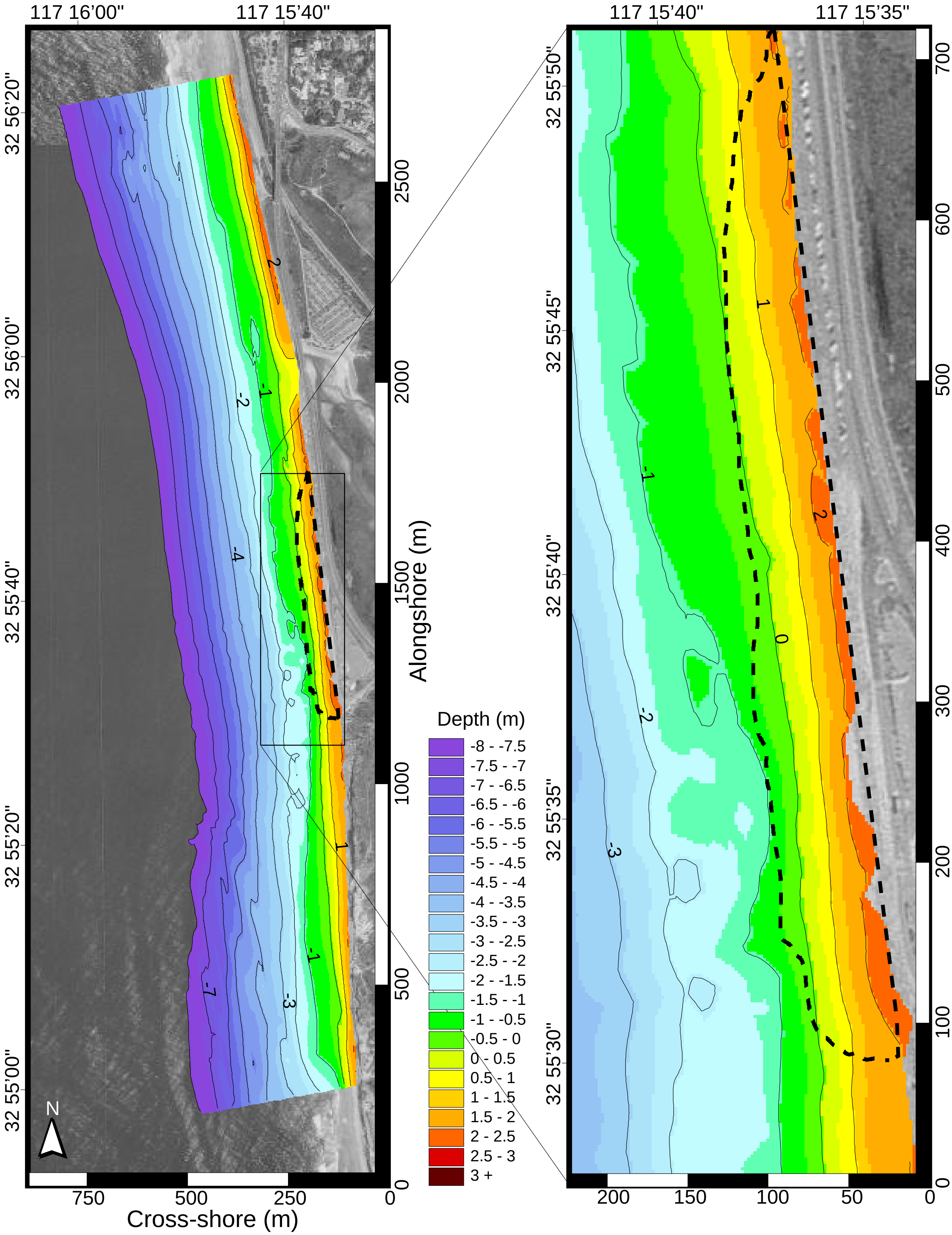

FIGURE 1b.

Left: Bathymetry measured 02 July 02 in a 3-km long strip centered on the initially nourished region (bounded by the black dashed line). The contour interval is 1.0 meters.

Right: Nourishment zone enlarged. The contour interval is 1.0 meters.

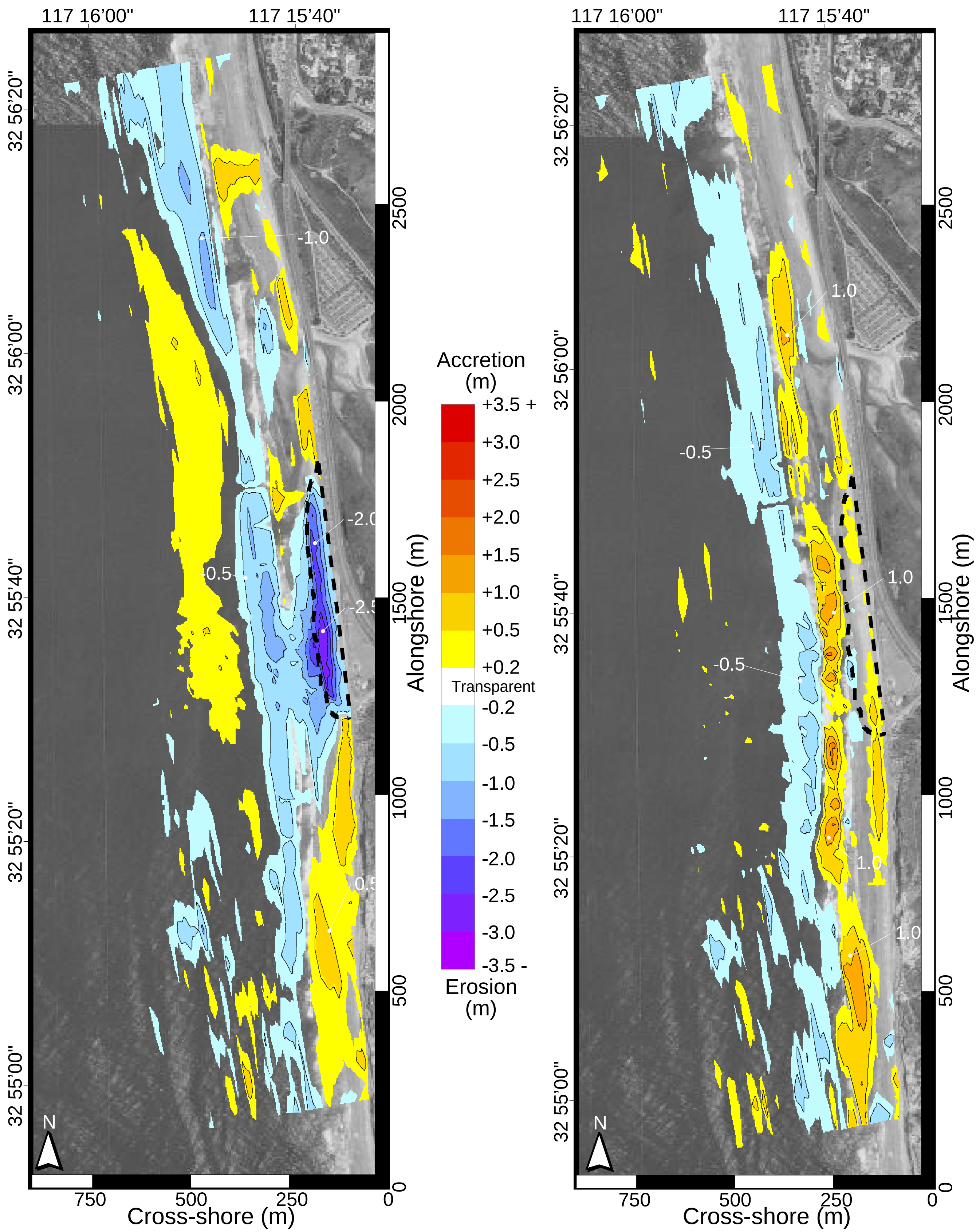

FIGURE 1c.
Left: Changes in sand level on 02 July 02 relative to 27 April 01 (the first post-nourishment survey). The contour interval is 0.5 meters (ignoring changes less than +/- 0.2 meters).
Right: Changes in sand level on 02 July 02 relative to 29 May 02 (the previous survey).

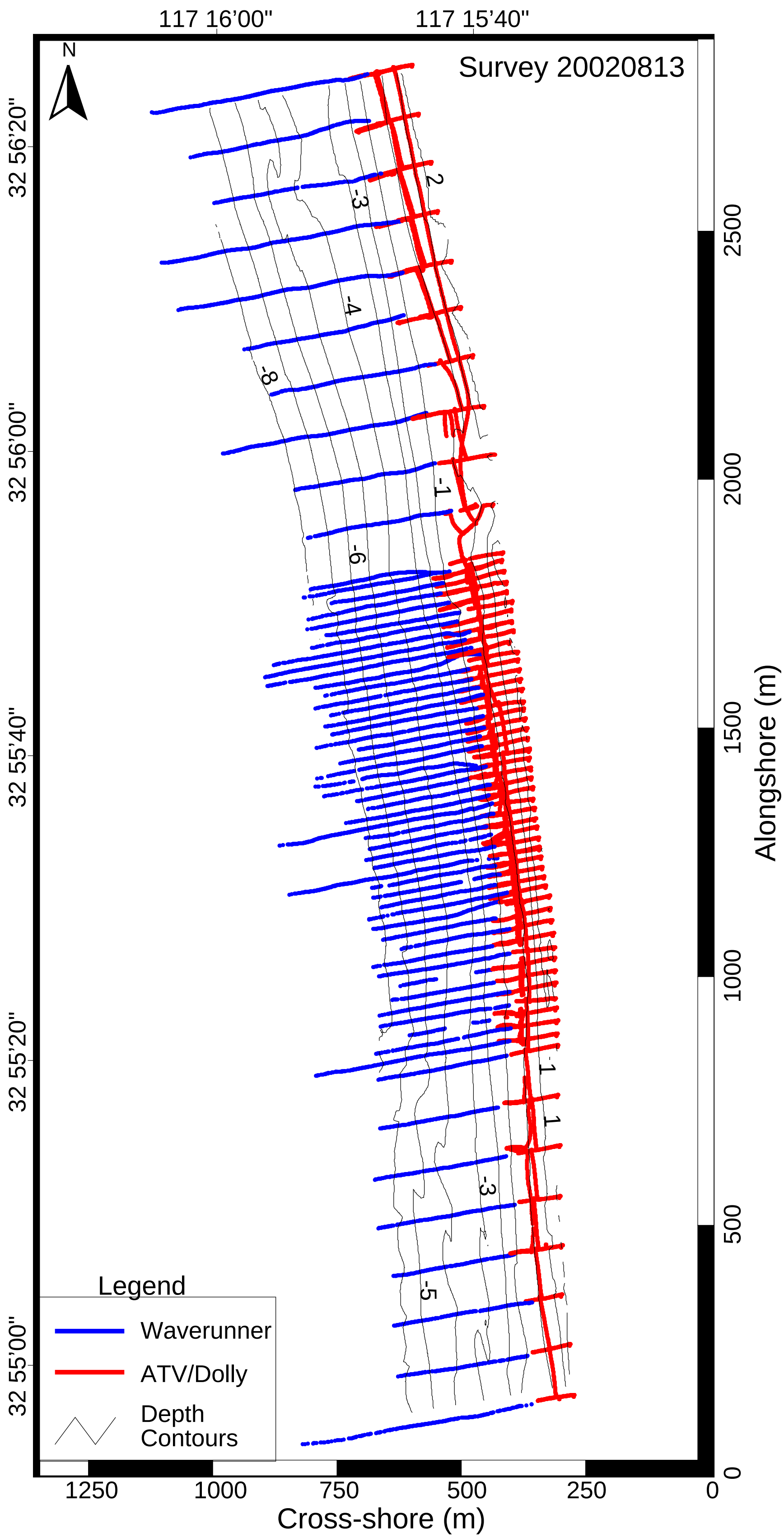

FIGURE 2a.
Survey starting 13 August 02. Blue lines are waverunner tracks (offshore). Red lines are ATV/dolly tracks (onshore). Black lines are depth contours in meters.

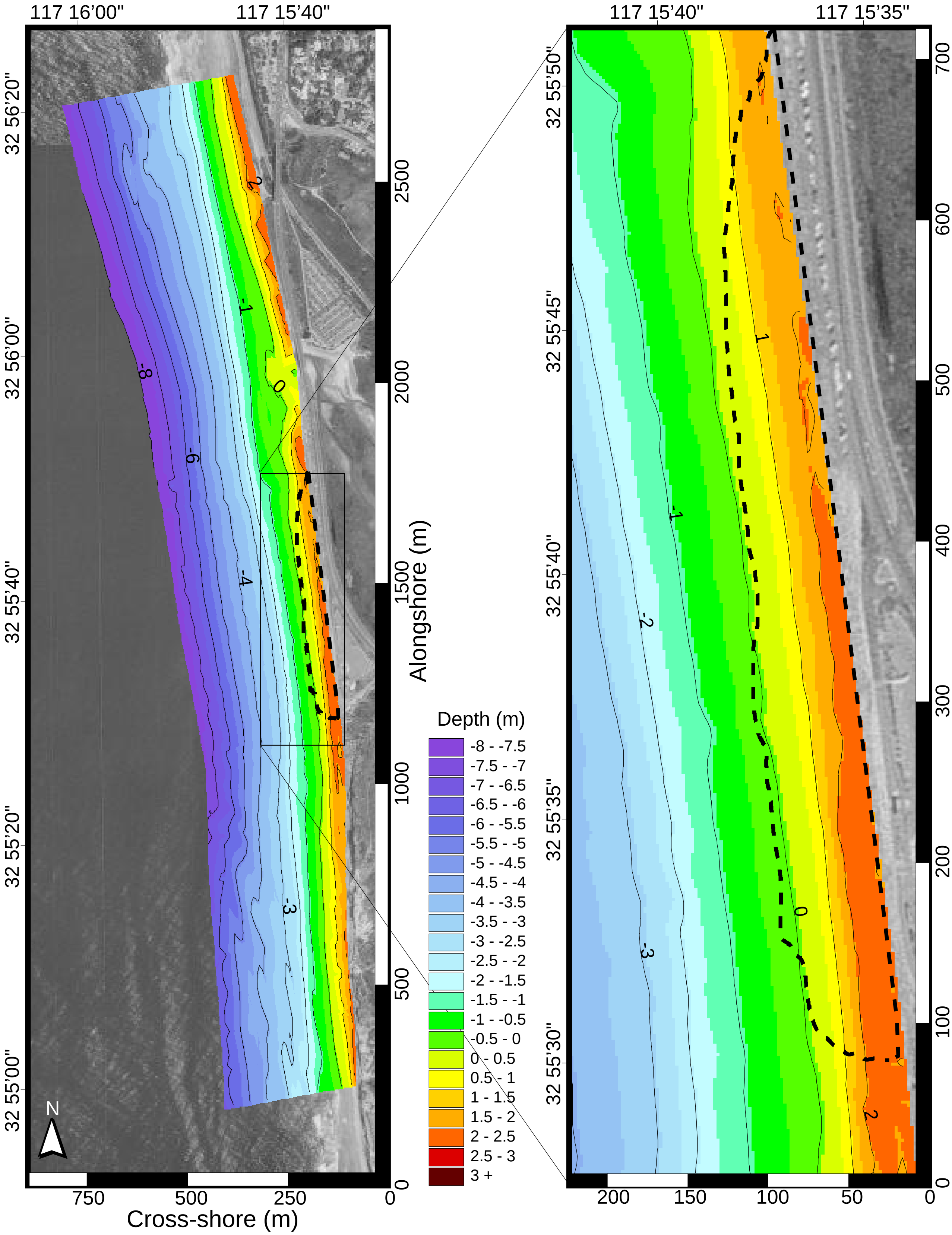

FIGURE 2b.

Left: Bathymetry measured 13 August 02 in a 3-km long strip centered on the initially nourished region (bounded by the black dashed line). The contour interval is 1.0 meters.

Right: Nourishment zone enlarged. The contour interval is 1.0 meters.

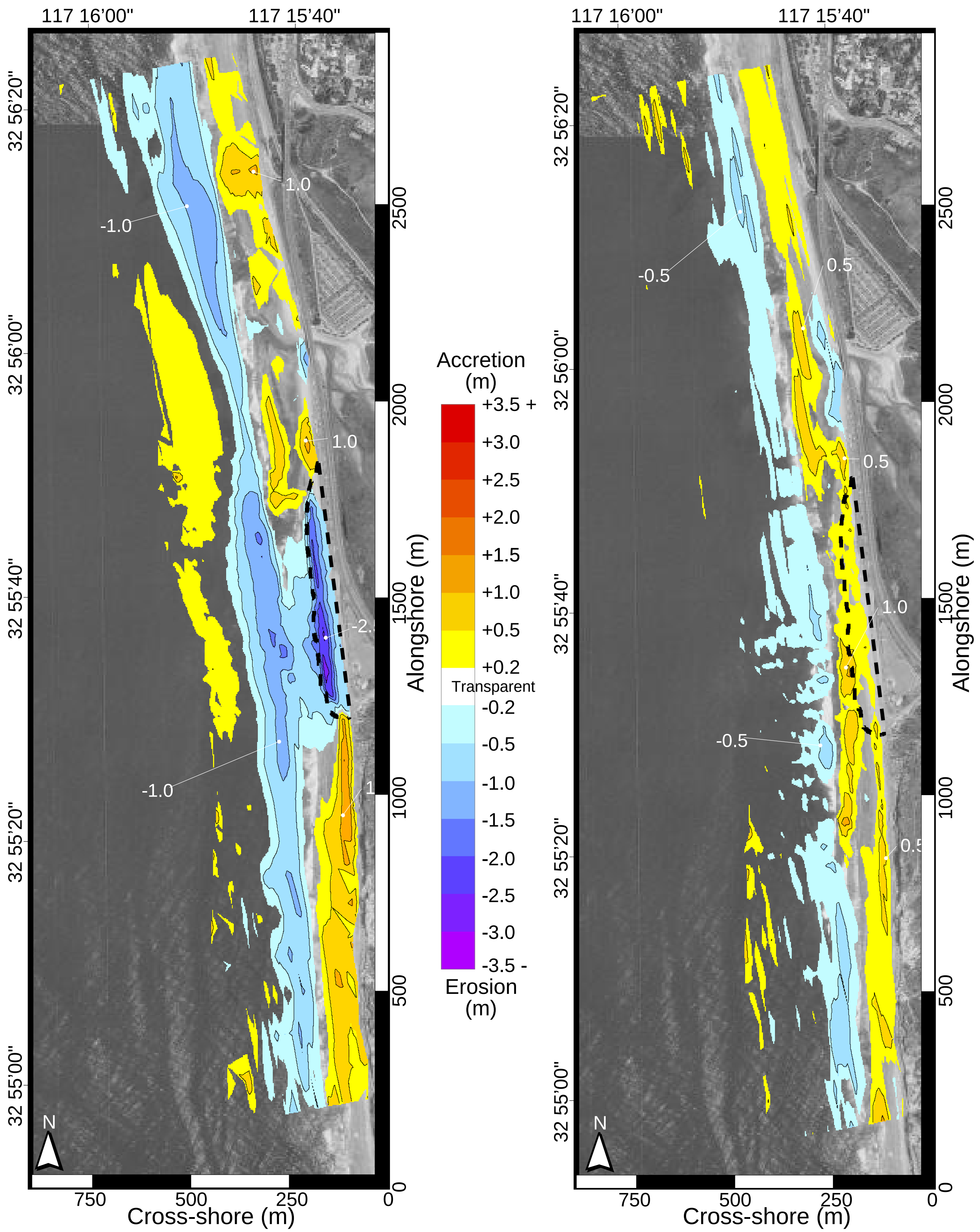

FIGURE 2c.
Left: Changes in sand level on 13 August 02 relative to 27 April 01 (the first post-nourishment survey). The contour interval is 0.5 meters (ignoring changes less than +/- 0.2 meters).
Right: Changes in sand level on 13 August 02 relative to 02 July 02 (the previous survey).

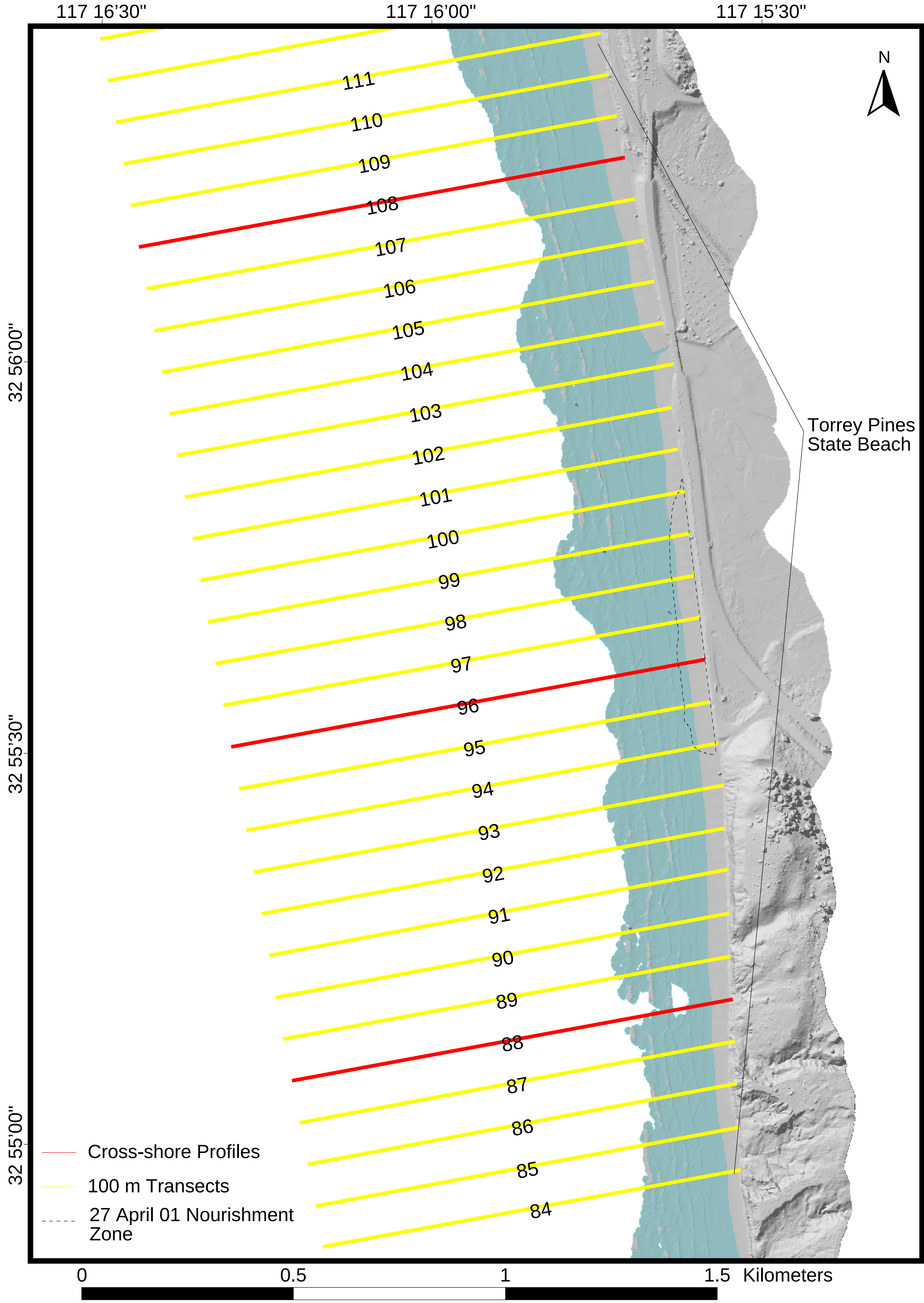

Figure 3a: Overview of cross-shore transects at Torrey Pines State Beach Study Site. Red lines are profiles in following figures (3b-d). Gray/blue image represents a sun-shaded surface derived from Lidar data collected 22 May 2002.

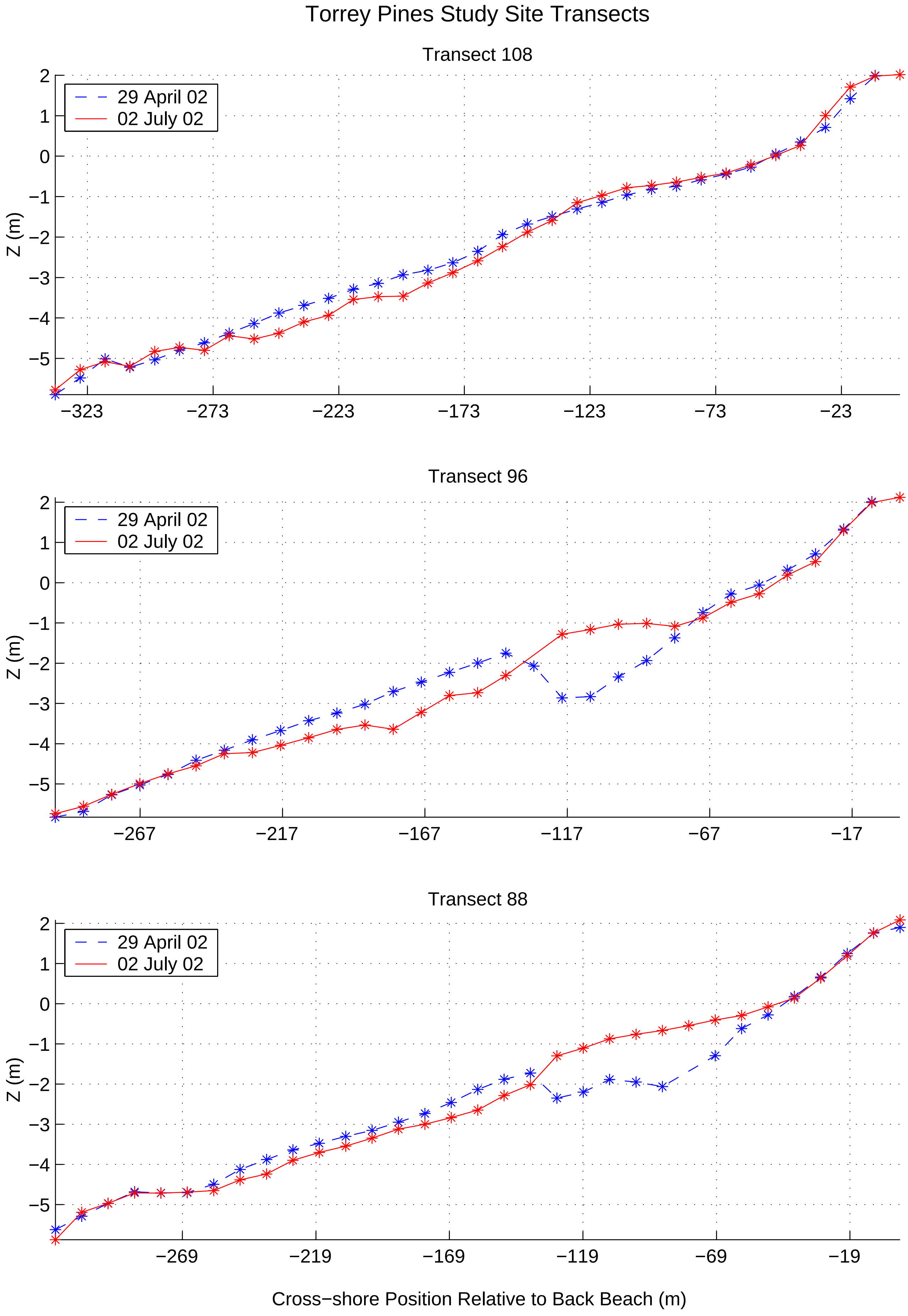

Figure 3b: Three cross−shore profiles at Torrey Pines State Beach: 29 May 02 (blue) and 02 July 02 (red). See Figure 3a for transect locations. Data points have been binned (averaged) at 10 m interval.

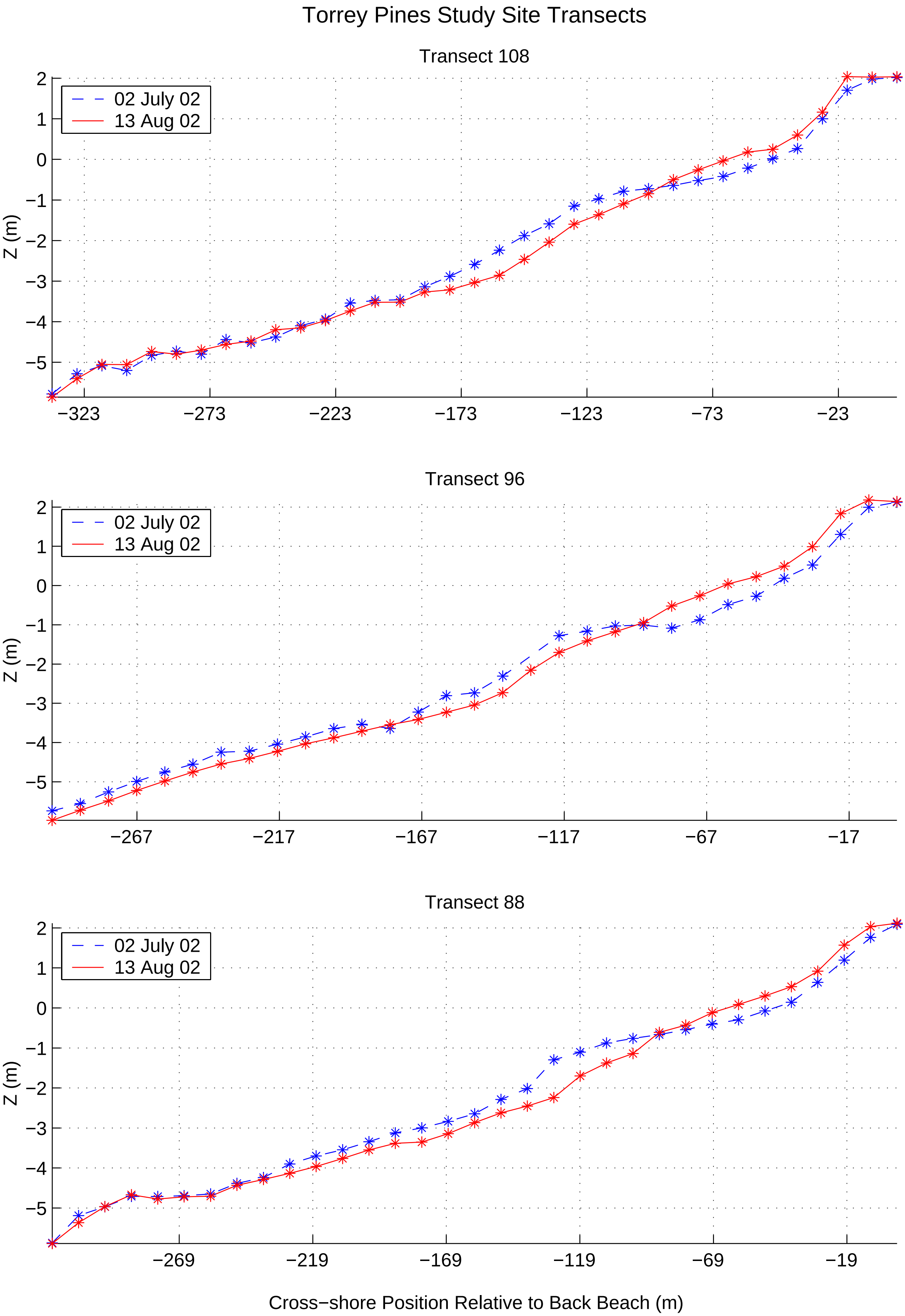

Figure 3c: Three cross−shore profiles at Torrey Pines State Beach: 02 July 02 (blue) and 13 August 02 (red). See Figure 3a for transect locations. Data points have been binned (averaged) at 10 m interval.

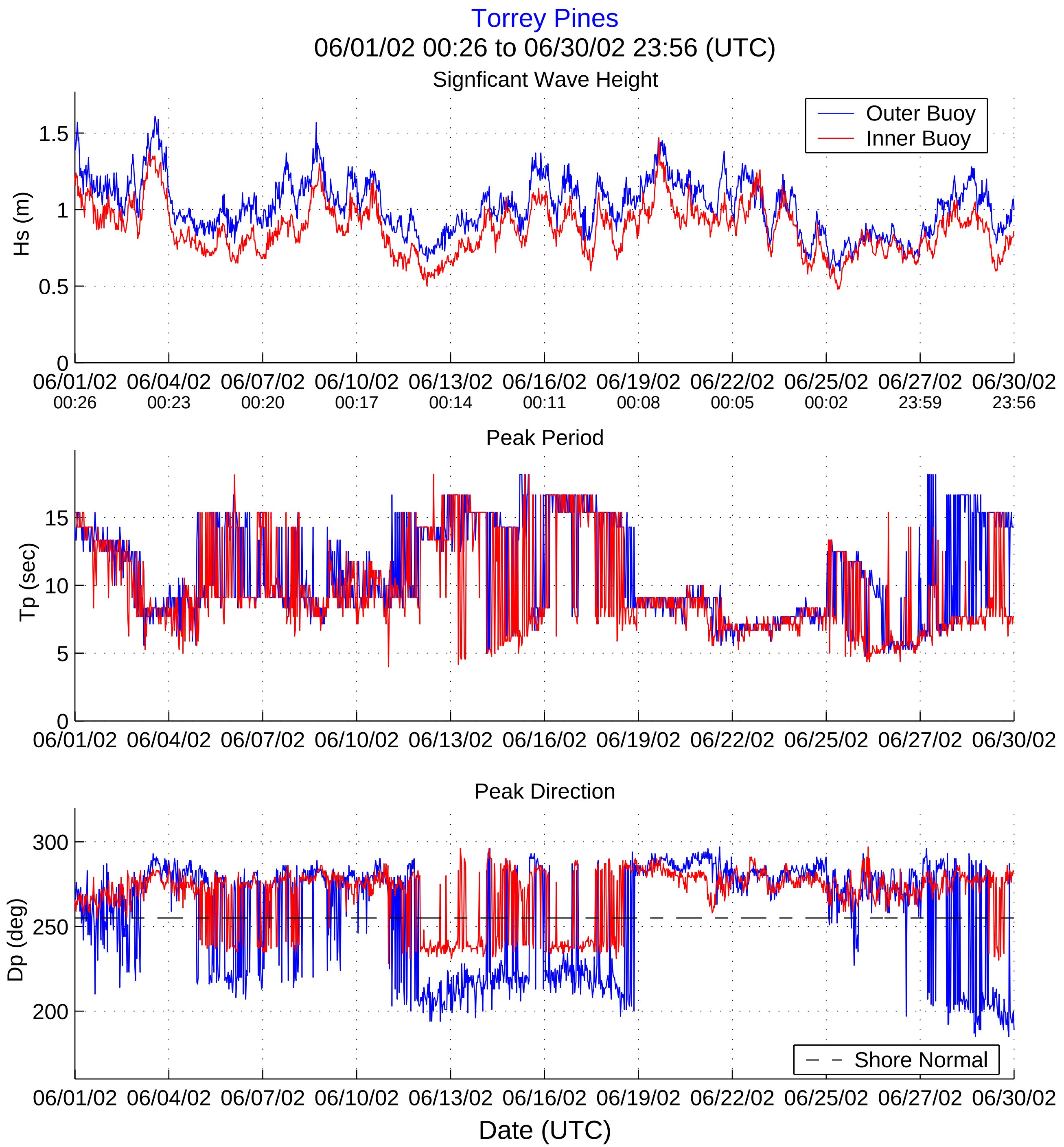

Figure 4a: June Wave Data for Torrey Pines Inner and Outer Buoys

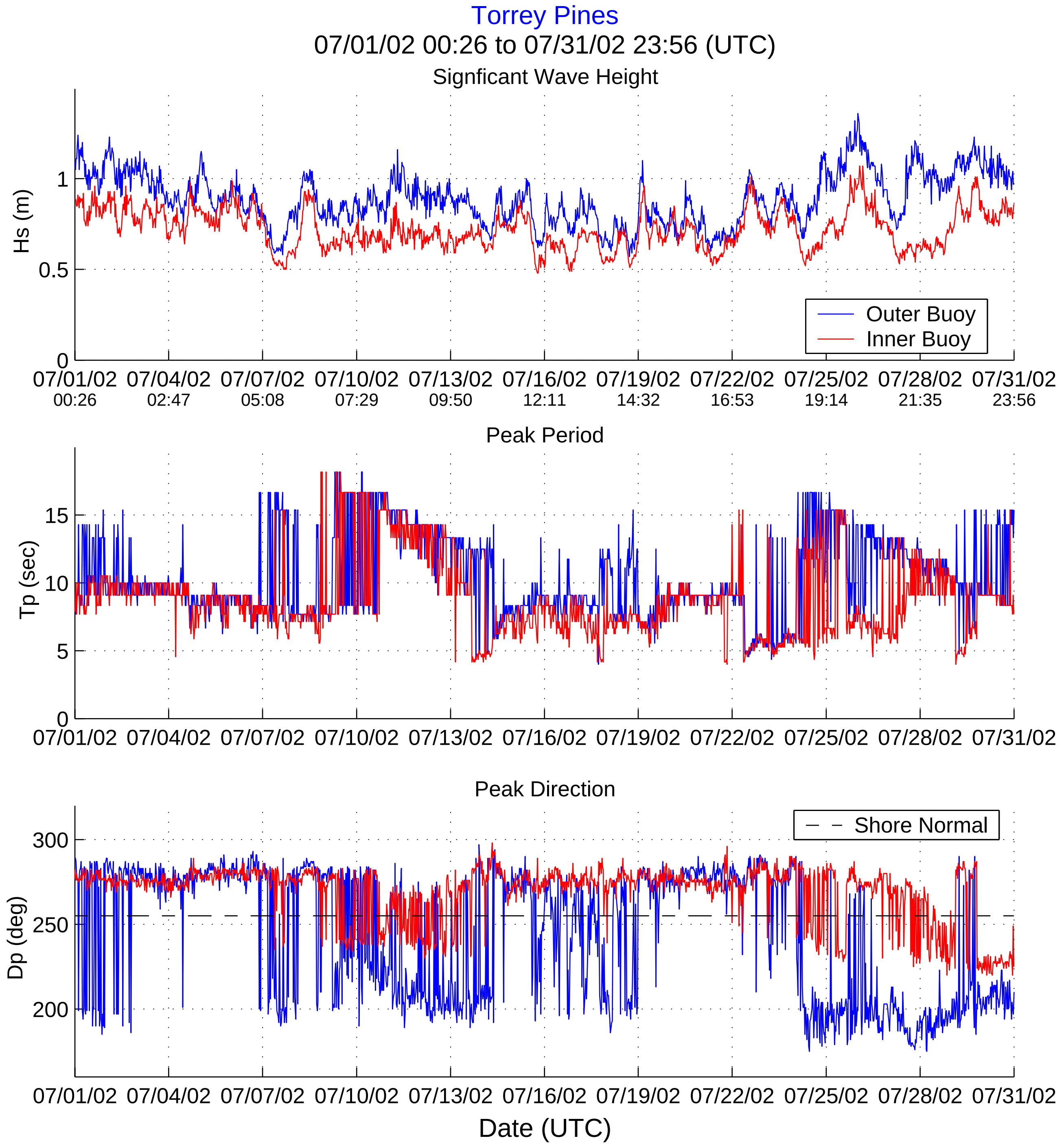

Figure 4b: July Wave Data for Torrey Pines Inner and Outer Buoys

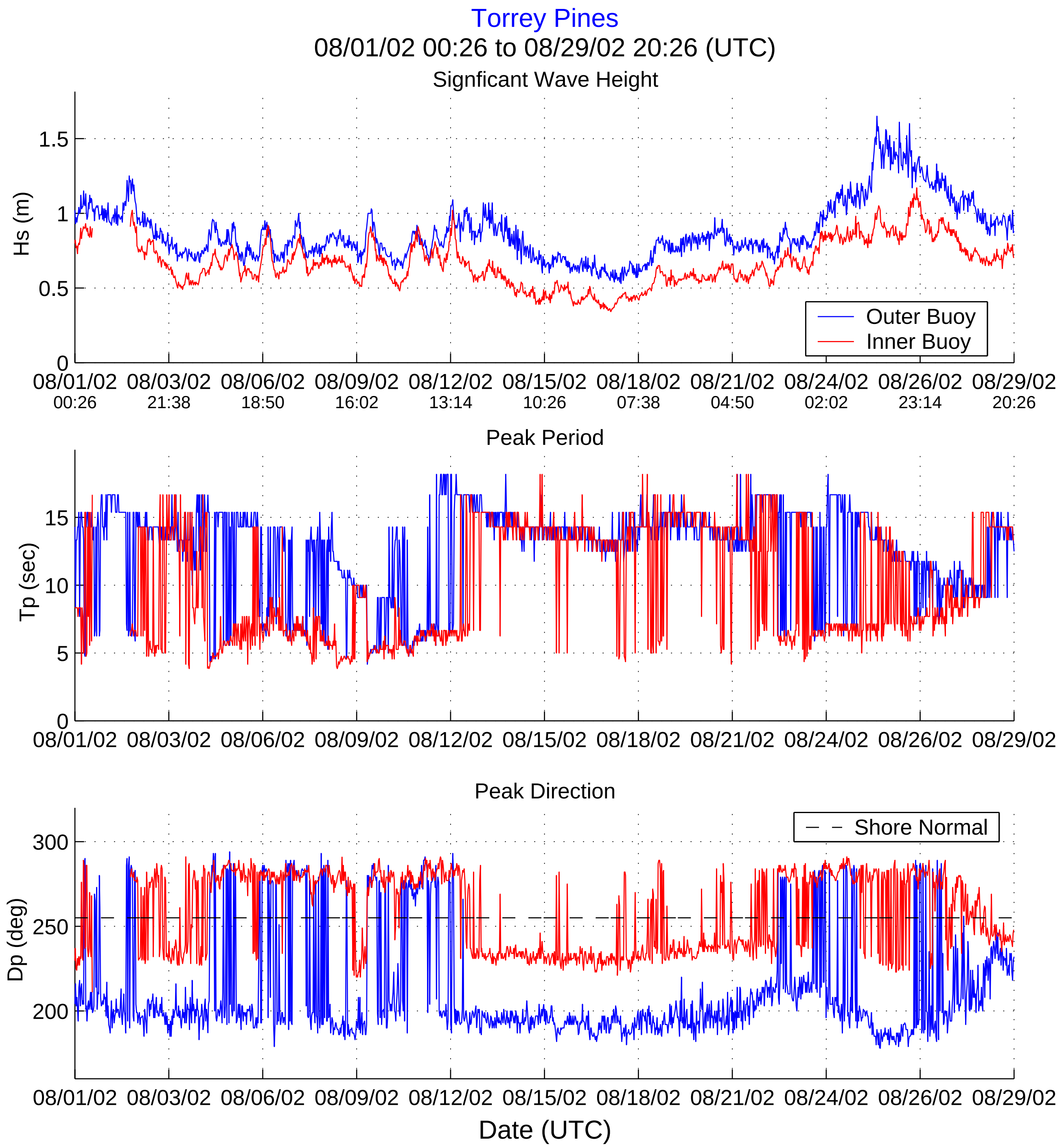

Figure 4c: August Wave Data for Torrey Pines Inner and Outer Buoys

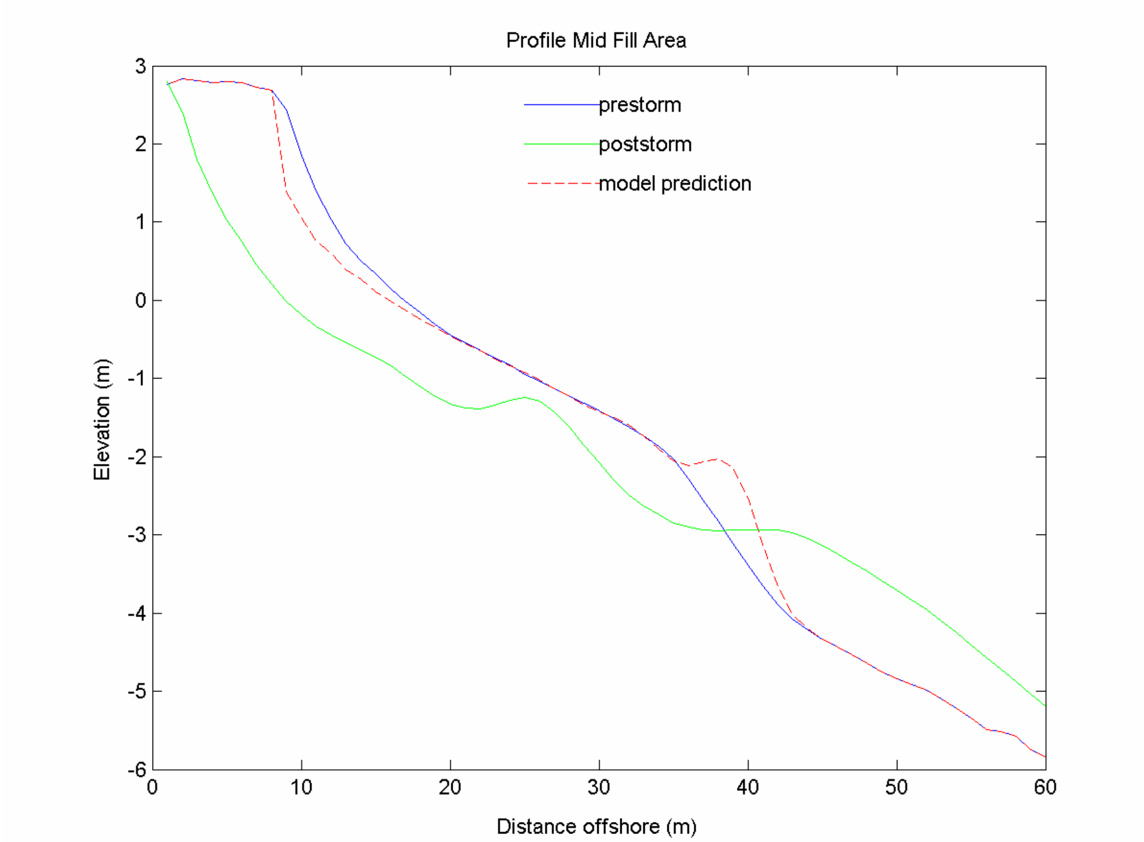

Figure 5. Actual and SBEACH modeled erosion of the fill area during November 2001 storm. Although the modeled erosion is maximized by using unrealistic parameter assignments, only about 17% of the actual erosion is predicted.

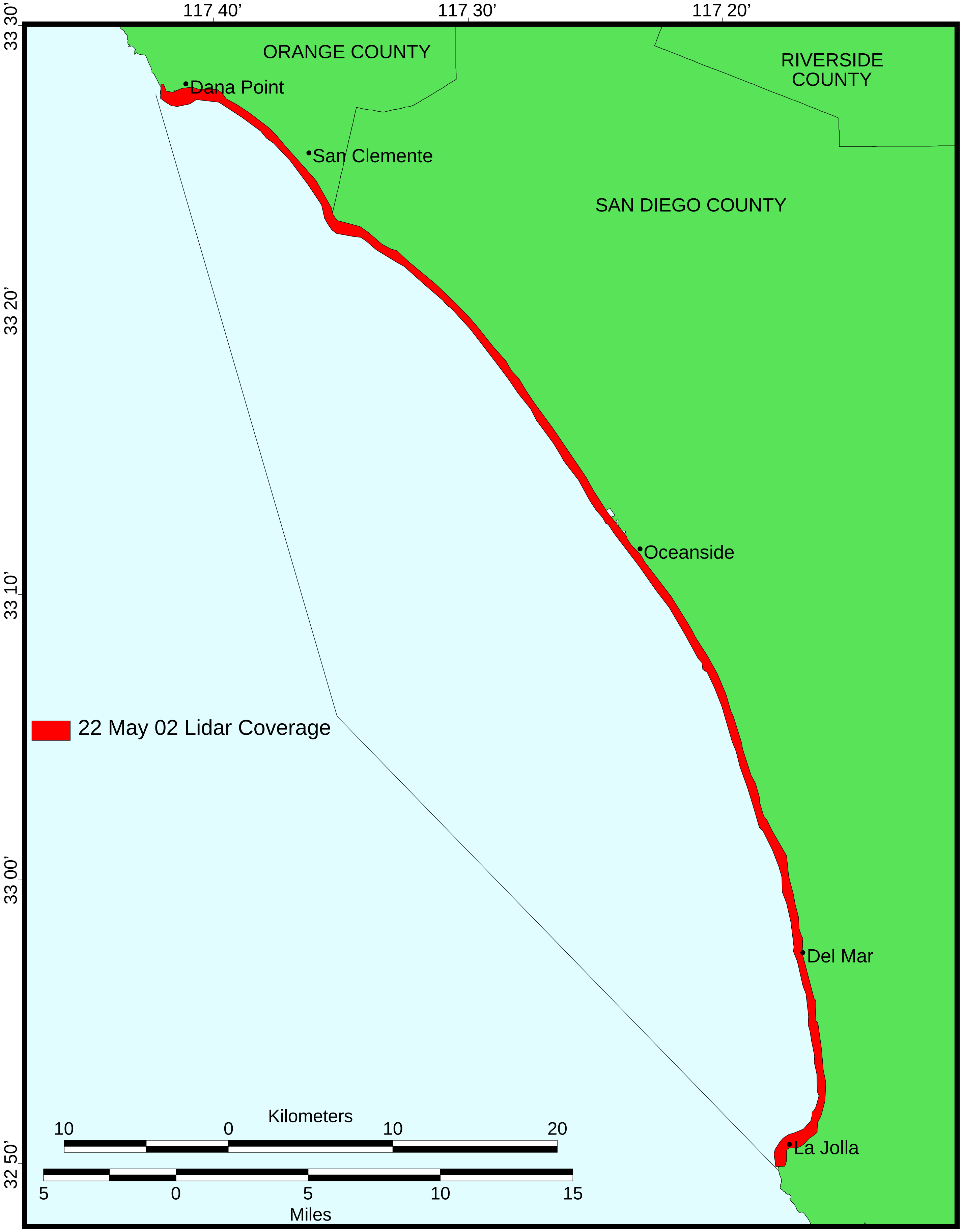

Figure 6a: Area covered by Lidar overflight 22 May 02 (red).

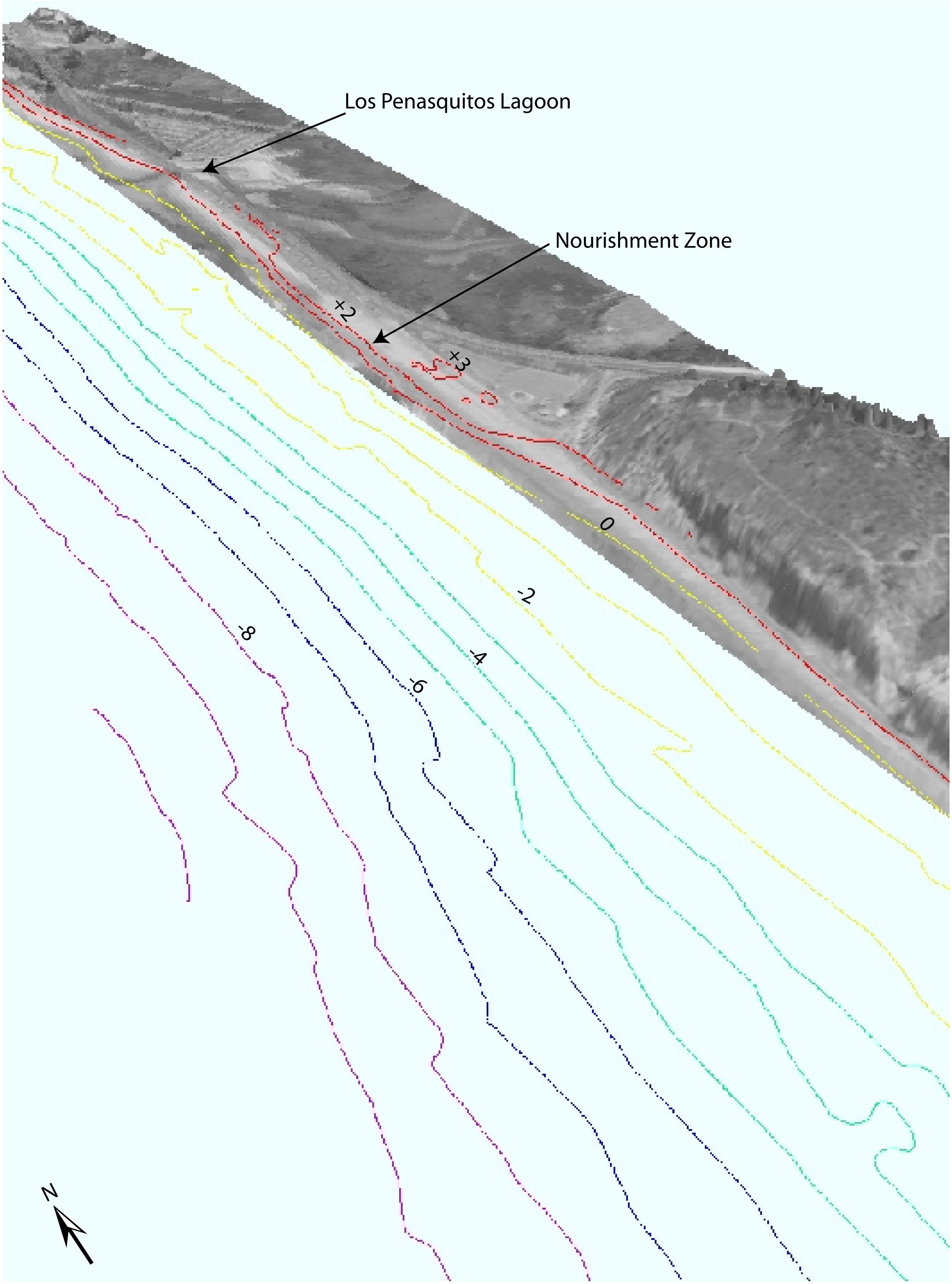

Figure 6b: 3-d perspective of Torrey Pines State Beach viewed from south-west. Bathymetry data (1m colored contours) was collected 27 April 2001 (First post-nourishment survey). Land elevation (gray portion) is represented by aerial image draped over Lidar data collected 22 May 2002.

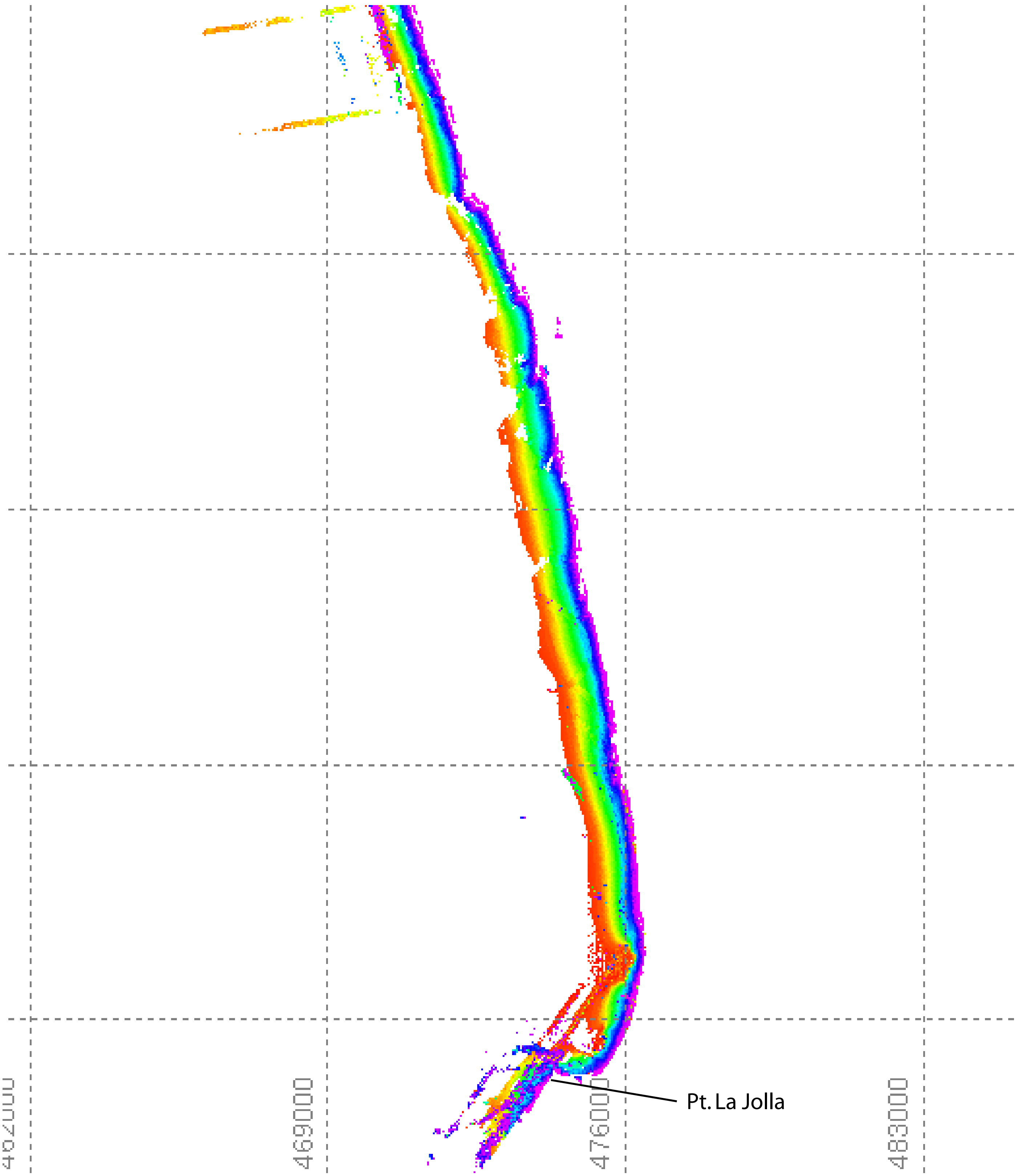

Figure 7a: Southern portion of SHOALS data set. Numbers are UTM Zone 11 coordinates represented in meters. Red is approximately -15 m and purple is approximately +1 m relative to NAVD88.

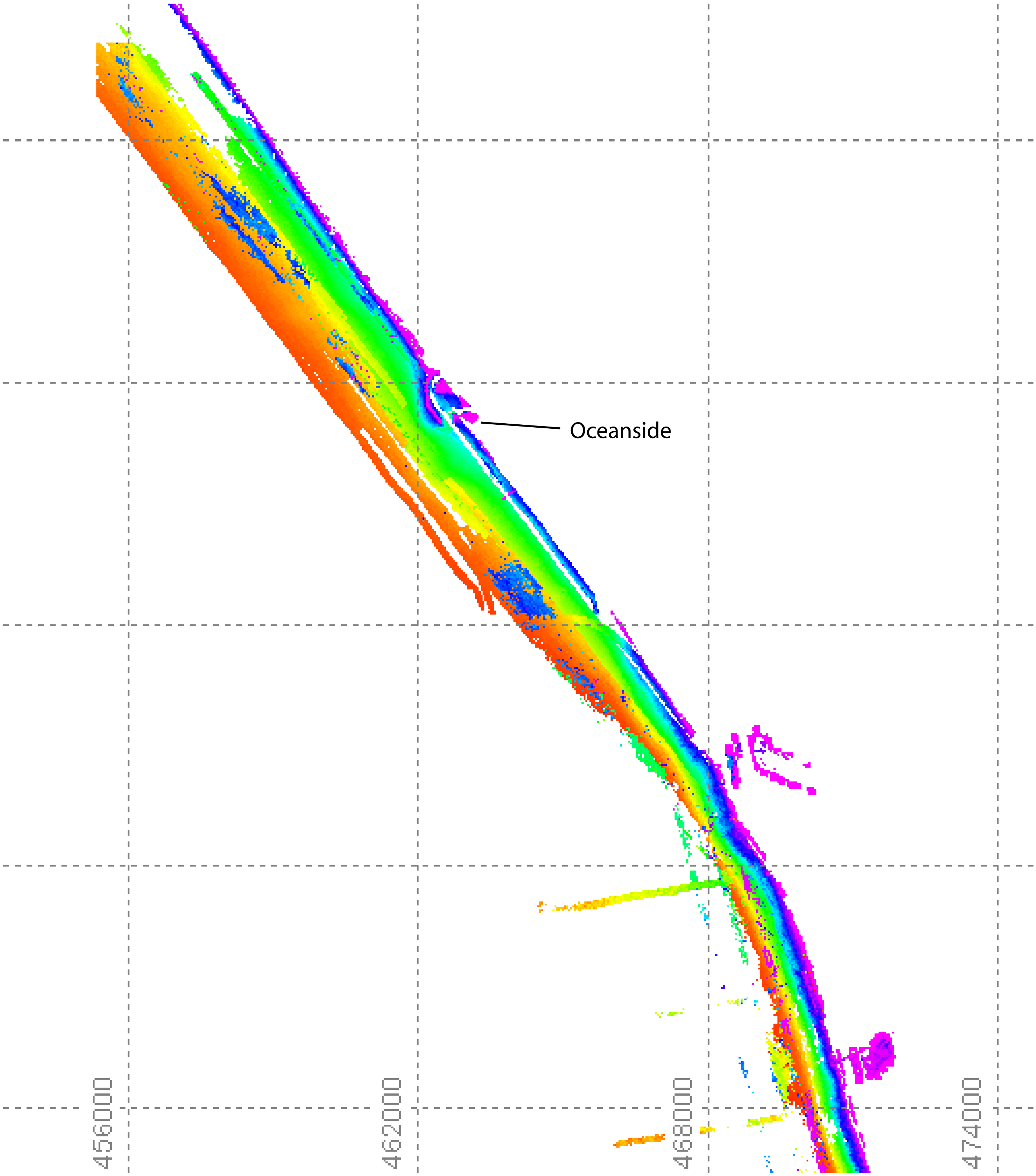

Figure 7b: Mid portion of Shoals dataset. Numbers are UTM Zone 11 coordinates representedin meters. Red is approximately -15 m and purple is approximately +1 m relative to NAVD88.

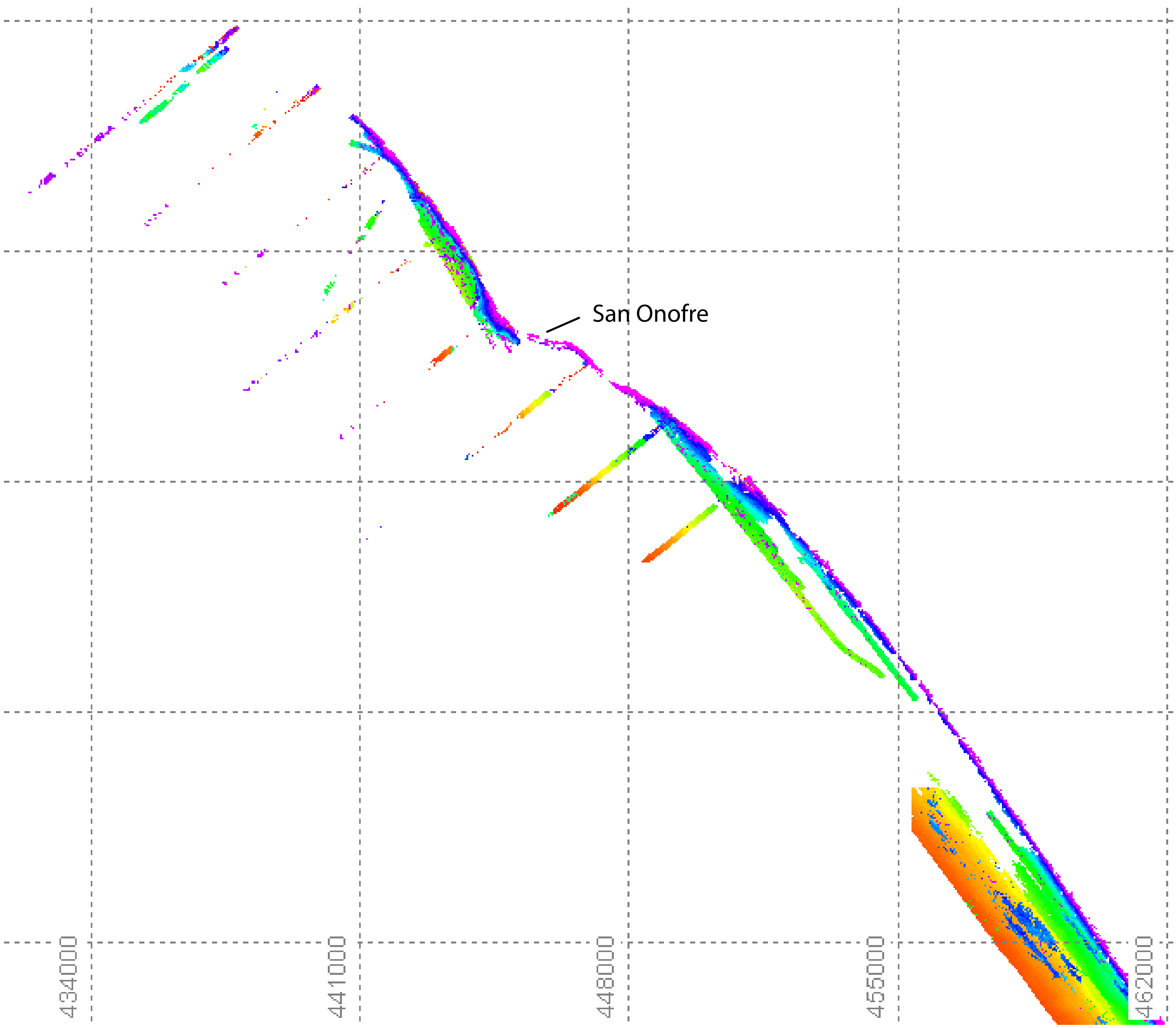

Figure 7c: Northern portion of SHOALS data coverage. Numbers are UTM Zone 11 coordinates represented in meters. Red is approximately -15 m and purple is approximately +1 m relative to NAVD88.

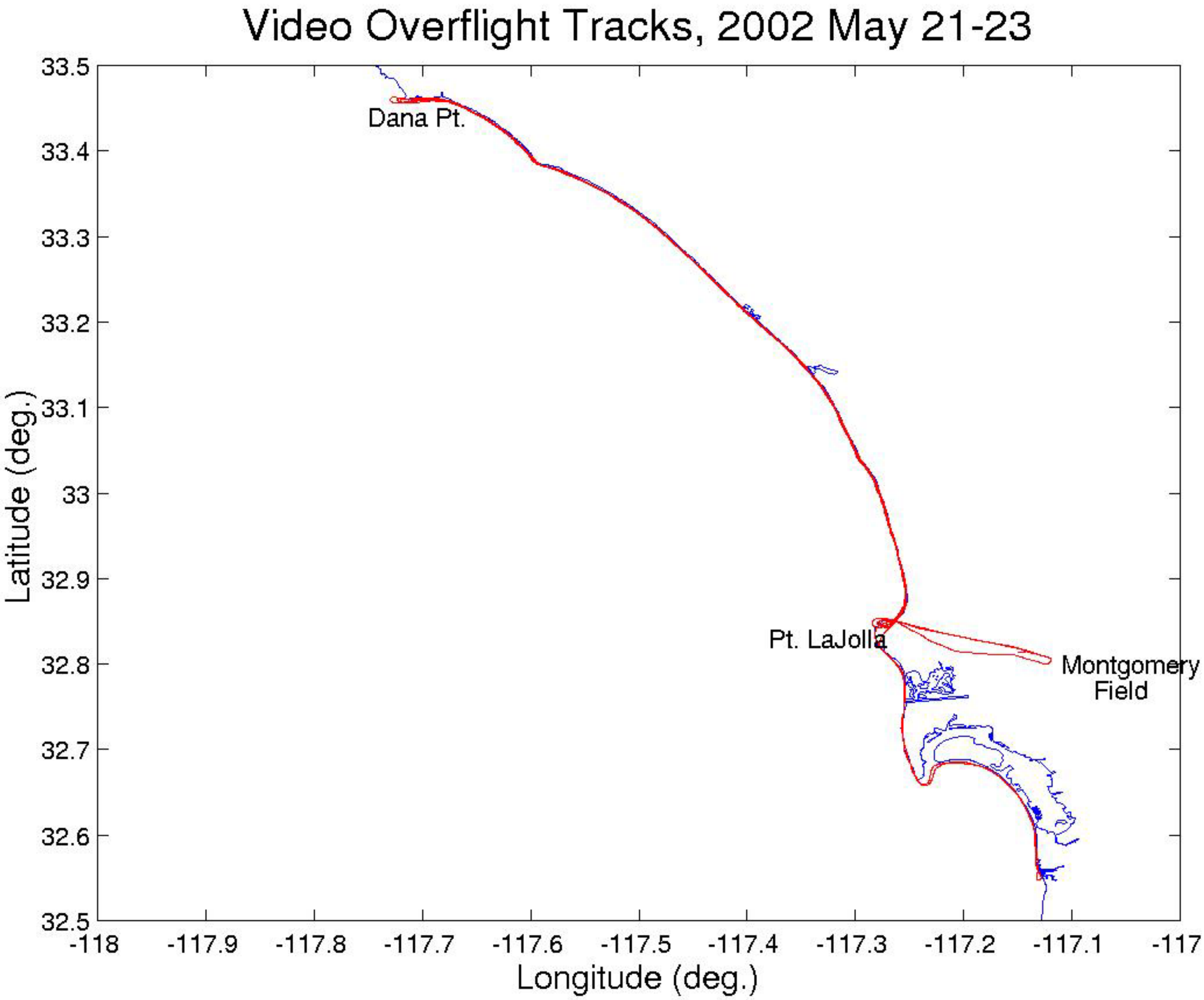

Figure 8a: Video flight-tracks (red) for the May 21-23 overflights.

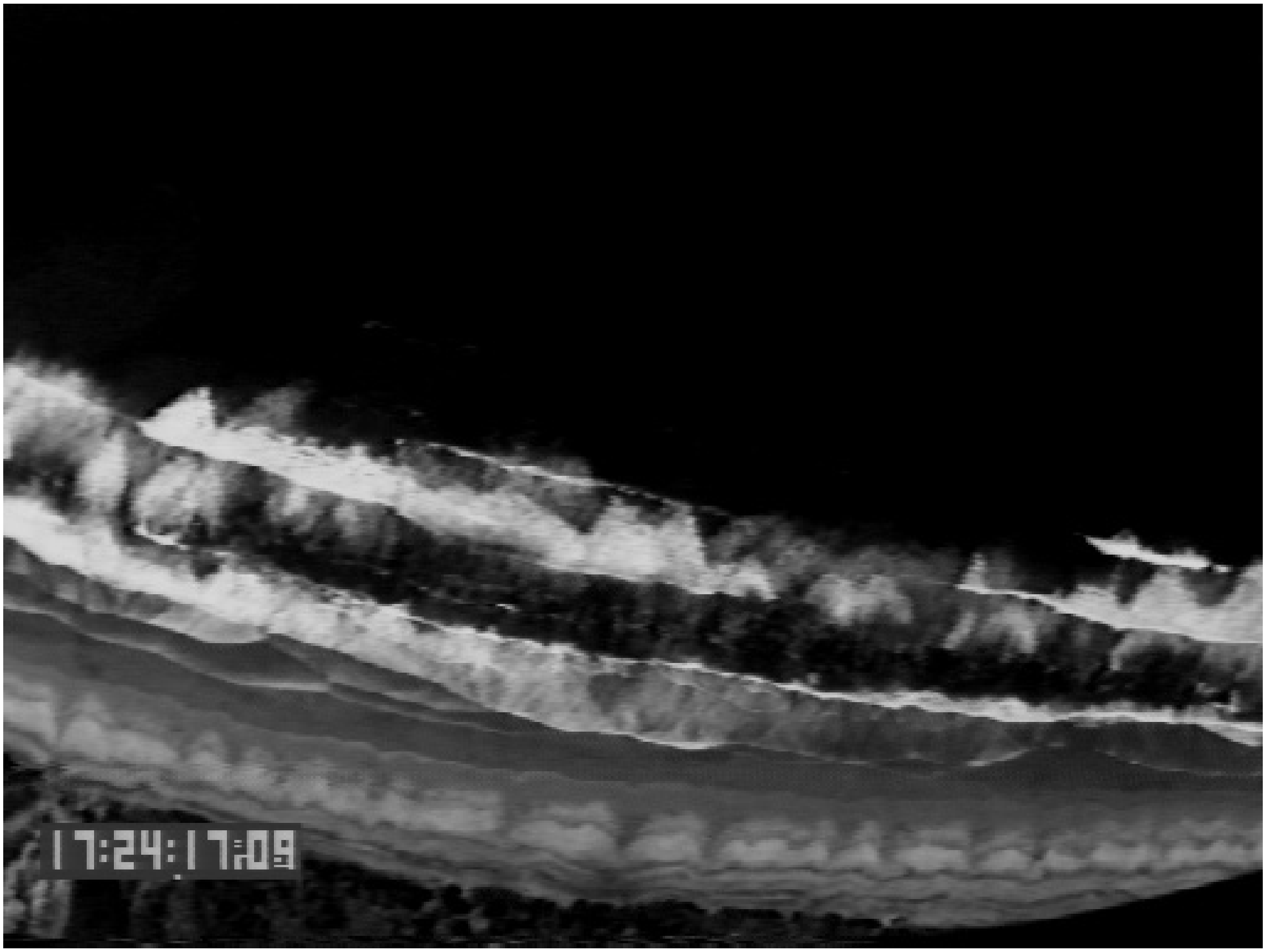

Figure 8b: JPG snapshot image obtained from the video record showing 1 km region near Blacks Beach. Visible is complicated high tide wet/dry line with beach cusps.

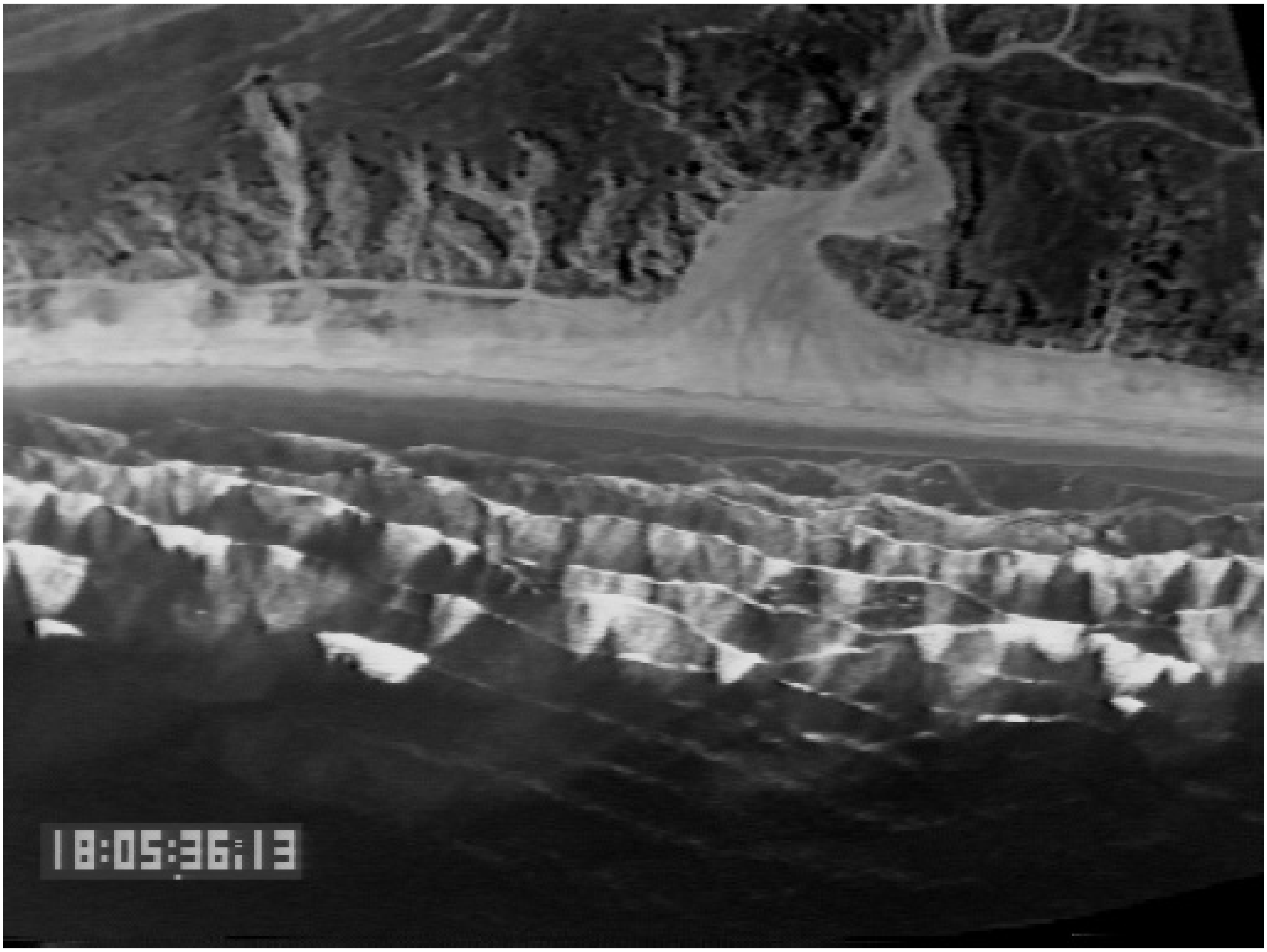

Figure 8c: JPG snapshot image obtained from the video record showing 1 km region near Camp Pendleton. The wet/dry line is straight and void of beach cusps.